

ProLiant BL e-Class C-GbE Interconnect Switch Overview

white paper



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Abstract

This white paper provides an overview of the ProLiant BL e-Class C-GbE Interconnect Switch option for the ProLiant BL e-Class system. The C-GbE Interconnect Switch option includes a pair of industry-standard layer 2 Ethernet switches that dramatically reduce the number of Ethernet network cables attached to the rear of the ProLiant BL e-Class server blade enclosure.

The intended audience for this paper is engineers and system administrators familiar with the ProLiant BL e-Class system. For those less familiar with the ProLiant BL e-Class system, the web page at <http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/index.html> provides essential information.

Introduction

The ProLiant BL e-Class system includes a 3U (5.25 inch) server blade enclosure supporting twenty server blades and redundant, hot-plug power and cooling. Since the ProLiant BL e-Class system packages many server blades in a small space, the number of network cables within this space can quickly become overwhelming. A ProLiant BL e-Class server enclosure with twenty ProLiant BL10e series servers contains forty 10/100 Mbps network adapter (NIC) Ethernet signals.

The e-Class server blade enclosure includes an interconnect tray that provides the connections for the Ethernet signals. HP offers a family of e-Class interconnect tray options allowing customers to choose the level Ethernet network signals consolidation. Interconnect options include two patch panel pass-through trays and an integrated Ethernet switch tray (the C-GbE Interconnect Switch). The two patch panel options allow all Ethernet network signals to pass through to third-party LAN devices, thus giving customers flexibility in choosing their own switches. The C-GbE Interconnect Switch includes redundant managed layer 2 Ethernet switches that provides up to a 40-to-1 reduction in network cables at the back of the BL e-Class enclosure. This cable reduction significantly reduces the time required to deploy, manage, and service ProLiant BL e-Class systems.

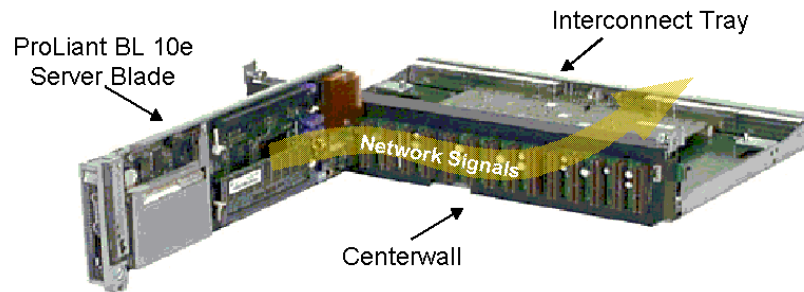
This white paper describes the e-Class C-GbE Interconnect Switch. The C-GbE Interconnect Switch is intended for applications that require 100 megabits per second (Mb/s) Fast Ethernet NIC consolidation to 10/100/1000T Gigabit Ethernet uplinks. For information on the patch panel pass through options, please see the [ProLiant BL e-Class System Overview and Planning](#) white paper.¹

e-Class network routing

The ProLiant BL e-Class server enclosure supports twenty BL10e series server blades, each with two NC3163 Fast Ethernet Embedded 10/100 Wake On LAN (WOL) network controllers enabled with Pre-boot eXecution Environment (PXE). Therefore, each server blade enclosure can have up to 40 network adapters. The signals from these 40 network adapters are routed from the servers via the passive centerwall assembly to an interconnect tray. Each e-Class server blade enclosure requires an interconnect tray. The interconnect tray slides into the rear of the server blade enclosure providing the Ethernet network connectors (Figure 1).

¹ Available at <http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/documentation-q2.html>.

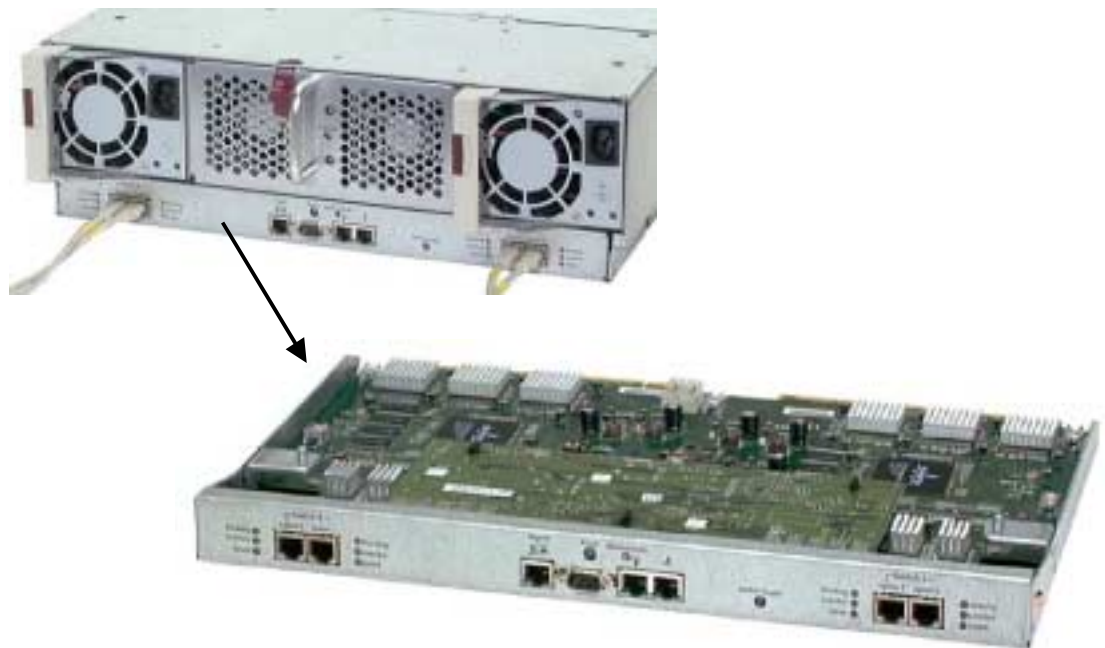
Figure 1. ProLiant BL e-Class network routing



C-GbE Interconnect Switch

The C-GbE Interconnect Switch is a ProLiant BL e-Class interconnect tray option that uses a pair of redundant, non-blocking, managed layer 2 Ethernet switches (Figure 2). The C-GbE Interconnect Switch consolidates 40 Ethernet NICs from the server blades into one to four external 10/100/1000T Gigabit Ethernet ports at the rear of the server blade enclosure. If desired, users can configure the C-GbE Interconnect Switch to concentrate the 40 Ethernet signals into a single external Ethernet port (see the section titled "Maximizing network cable reduction").

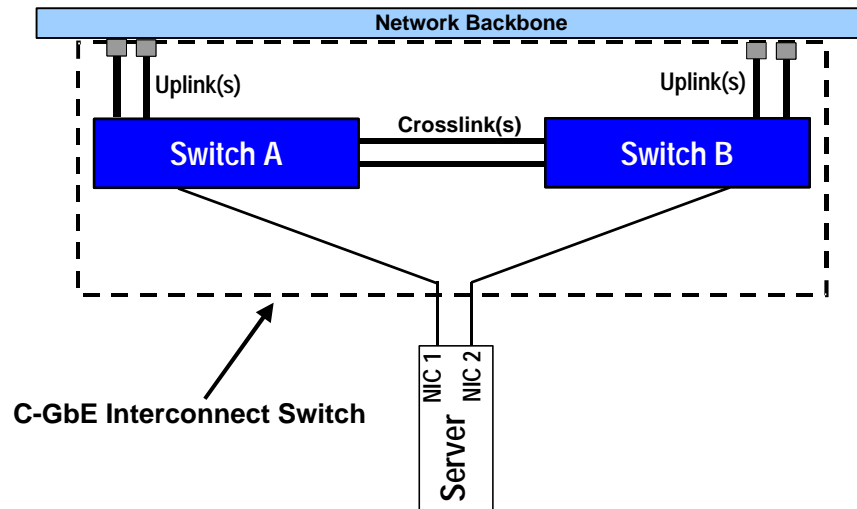
Figure 2. ProLiant BL e-Class server blade enclosure (back view) with the C-GbE Interconnect Switch tray option



Same technology, different form factor

In a typical server network configuration designed with redundancy, two or more network interface controller (NIC) ports are used per server. These NIC ports are routed to two separate access switches. One or more connections are commonly made between the switches for added availability. The switches are used to collect NIC signals from the servers for aggregation to the network backbone via one or more uplinks. The C-GbE Interconnect Switch and e-Class blade architecture accomplish the same thing using the same technology, but in a different form factor (Figure 3).

Figure 3. Typical redundant network configuration



With the C-GbE Interconnect Switch, the access switches and connections have been moved inside the BL e-Class server blade enclosure. The same network technology is used and the network configuration and administration remain unchanged. That is, the interconnect switch is configured and administered in the same manner as other industry-standard Ethernet switches. The interconnect switch is an industry-standard managed layer 2 switch compatible with other industry-standard switches.

Interconnect switch architecture

The interconnect switch features a fully redundant architecture that includes switch redundancy (dual switches or switch ASICs²) and redundant paths to the network ports on the server blades (Figure 4). Two NICs per each of twenty servers (forty NICs total) are routed to the switches in highly available design. This creates a fully meshed topology to the external Ethernet network. The interconnect switch tray is cooled by hot-pluggable redundant fans and powered by hot-pluggable redundant power supplies.

The redundant architecture of the C-GbE Interconnect Switch allows system administrators to configure the network for continued access to each server blade in case any of the following components should fail:

- Interconnect switch
- Switch within the network backbone
- Server blade network controller

² Each switch consists of a Broadcom BCM5605 layer 2 application specific integrated circuit (ASIC).

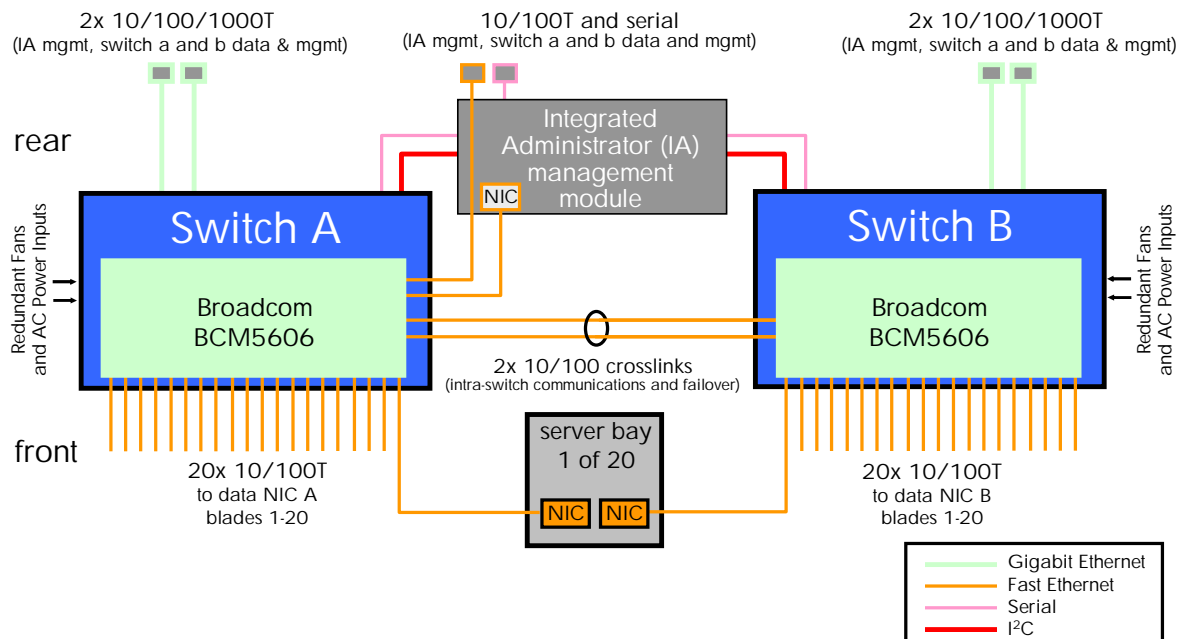
- Server blade NIC-to-interconnect switch port or connection
- Uplink port and uplink port connection and cable
- Interconnect switch cross-link port or connection
- Power and fan failure

Users can independently disable or enable the switch ports as desired. Auto-MDI/MDIX with auto-negotiation of speed and duplex mode is supported. The C-GbE Interconnect Switch tray includes the following Ethernet ports:

- Forty-one dedicated internal 10/100 Mb/s Fast Ethernet ports
 - Forty downlink ports connecting the server NICs to the two switches.
 - One port connecting switch A to the e-Class Integrated Administrator.
- Five external Ethernet ports for data, switch A and B management, Integrated Administrator management, and/or pre-boot execution environment (PXE) remote configuration.
 - Four 10/100/1000T Gigabit Ethernet uplinks (two per switch).
 - One 10/100T external Fast Ethernet port ideal for system management or as an additional uplink.
- Two dedicated internal Fast Ethernet crosslink ports per switch bundled as a 200 Mb/s multi-port trunk for switch-to-switch communication and failover, if desired.

These Ethernet ports are described in the following subsections.

Figure 4. ProLiant BL e-Class C-GbE Interconnect Switch architecture



Internal ports

The C-GbE Interconnect Switch includes forty pre-assigned, internal 10/100 Mb/s Fast Ethernet “downlink” ports connecting the server blade network adapters signals to the switches. The signals are routed as Ethernet from the server blades, across individual category 5e (CAT5e) specified signal traces on the passive centerwall assembly of the server blade enclosure, and then to the switches

(labeled Switch A and Switch B). Each switch directly connects to one of the two NC3163 NICs on each ProLiant BL10e series server blade (labeled as NIC).

One additional 10/100 Mb/s Fast Ethernet internal port connects the Integrated Administrator (IA) to the switches for IA to switch Ethernet communication.

External ports

The C-GbE Interconnect Switch includes four external 10/100/1000 Mb/s Gigabit Ethernet “uplink” ports with RJ-45 connectors, typically used to connect the interconnect switches to the network infrastructure. However, they are standard Ethernet switch ports and may be used as desired. Two of the ports are connected to each switch that may be bundled into an EtherChannel compatible trunk.

In addition, one 10/100T Fast Ethernet external port with an RJ-45 connector is provided from switch A. This port is ideal for a dedicated management network or for local administration and diagnostic tasks without unplugging a dedicated uplink. Simultaneous management access to switch A, switch B, and the IA is possible via this single port (or any other external Ethernet port). Although ideally suited for management, this is also a standard Ethernet switch port that may be used as desired, such as an additional data uplink to the network.

Crosslink ports

The redundant layer 2 switches are connected through a pair of redundant, 10/100 Mb/s Fast Ethernet “crosslink” ports that are bundled into a 200 Mb/s Cisco EtherChannel compatible multi-port trunk. The signals are routed as Ethernet from switch to switch via individual CAT5e specified signal traces on the passive centerwall assembly of the server blade enclosure. The crosslinks permit communication between the switches, if desired. They also provide the ability to:

- Manage both switches, perform PXE server boots, and access the IA using just one to any number of external switch ports. Therefore, any single external Ethernet port can be used to perform all Ethernet management tasks.
- Configure the e-Class system for advanced ProLiant Network Adapter Teaming including switch fault tolerance. See the section “ProLiant Network Adapter Teaming” for additional information.
- Communicate with any server network adapter from any external Ethernet port. As a result, any single external Ethernet port may be used to communicate to all forty NICs. This permits the 40-to-1 cable reduction and provides additional system redundancy. If uplinks on one switch or the connection to it were to fail, all NICs still can be accessed via the other switch.

Maximizing network cable reduction

For maximum (98 percent) cable reduction, the 40 Ethernet NIC signals within the server blade enclosure can be concentrated into any one single external Ethernet port. This results in a total of only fourteen Ethernet connections for a fully configured 42U rack of fourteen server blade enclosures containing 560 network adapters.

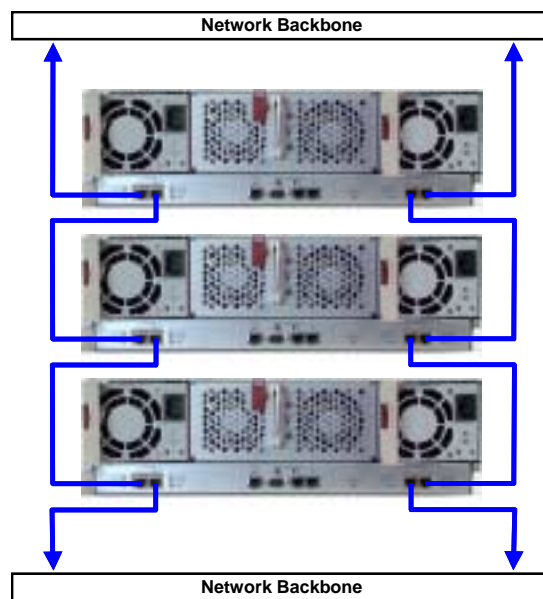
Applications that utilize a single uplink port include testing and evaluation systems, server blade enclosures with a few installed servers, and applications that require minimal bandwidth. On a heavily utilized system, using a single uplink port for all 40 network adapters can cause a traffic bottleneck. For example, using one uplink from interconnect switch A requires the traffic from all the network adapters routed to switch B to travel over the two crosslink ports (a 200 Mb/s path), previously shown in Figure 4. The crosslink ports are intended primarily as a failover route and generally are not used as a primary path. For more optimal performance, at least one uplink port on each switch would be used. However, system administrators may use any combination from one to all five external Ethernet ports to increase bandwidth, to separate network and management data onto physically isolated ports, or to add redundant connections to the Ethernet network backbone.

Enclosure linking

Another means to achieve network cable reduction includes linking of an e-Class GbE Interconnect Switch with other ProLiant BL e-Class and even p-Class interconnect switches from different server blade enclosures. This is ideal for customers with multiple blade enclosures within a rack. It also allows the network administrator to define the desired level of network blocking or oversubscription.

For example, Figure 5 shows a configuration with three fully populated BL e-Class server blade enclosures, each with the C-GbE Interconnect Switch tray installed. The interconnect switches are linked, or daisy chained, together in redundant configuration using the four gigabit uplinks that, in turn, are connected to the Ethernet network backbone. Each enclosure contains forty 10/100 Fast Ethernet network adapters with an aggregate bandwidth of four gigabits per second (Gb/s), for a total bandwidth of twelve Gb/s for entire system of three enclosures. However, since uplinks are daisy chained together, the maximum system throughput for this configuration is 4.0 Gb/s (the combined throughput of the four daisy chained gigabit ports). This configuration creates a 3x blocking ratio (12 Gb/s versus 4 Gb/s); nevertheless, it reduces the total Ethernet network cables at the rack level from 120 to 4, a 97 percent cable reduction, while maintaining redundant connections to the Ethernet network backbone.

Figure 5. ProLiant BL e-Class C-GbE Interconnect Switch linking



In this example, four gigabit uplinks per server blade enclosure were used. Because each C-GbE Interconnect Switch tray also provides an additional 10/100T Fast Ethernet port, other linking configurations are possible. Additionally, the two switches on each tray are connected by redundant crosslink ports, which provide added configuration possibilities.

Network load balancing

ProLiant BL systems configured with the interconnect switch support three network load balancing solutions. Options exist for providing this functionality integrated within or exterior to the server blade enclosure.

For load balancing within the server blade enclosure, the F5 Network BIG-IP Blade Controller (BIG-IP) may be used. BIG-IP is a software option for ProLiant BL e-Class and p-Class systems that provides a very economical solution to load balancing and traffic management between multiple server blades that reside in a single to multiple server blade enclosures.

BIG-IP is available from F5 Networks as a software option installed on ProLiant server blades. One license is installed on a server making the server blade into a “dedicated” load balancer; no additional software can be installed on the server blade. For a redundant solution, two copies of BIG-IP are installed on two server blades. The server blade(s) with BIG-IP installed may perform load balancing on blade servers that reside in the same or different server blade enclosures, both e-Class and p-Class. The blade servers may be located anywhere on the network as long as load balanced traffic to and from the servers pass through the BIG-IP Blade Controller. For more information on BIG-IP Blade Controller for ProLiant BL systems, see <http://h71028.www7.hp.com/enterprise/html/4557-0-0-0-121.html>.

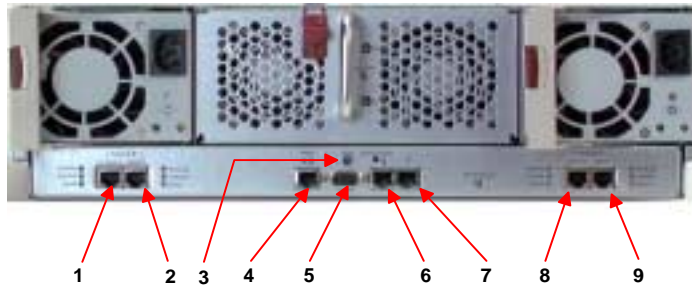
For load balancing exterior to the server blade enclosure, a third party layer 7 Ethernet switch or network load balancing appliance may be used. This traditional approach uses a multi-tiered architecture where the interconnect switches are connected to one or more layer 7 switches or network load balancing appliances. Layer 7 switches and network load balancing appliances are available from several network vendors including Cisco, F5, Nortel, and others. This solution is supported on both e-Class and p-Class configured with any interconnect.

Switch management

The C-GbE Interconnect Switch is an industry-standard managed Ethernet switch meaning users configure and manage the switch like other industry-standard Ethernet switches. To aid users during initial deployment, the C-GbE Interconnect Switch includes a default configuration that is fully operational at initial boot.

A web browser-based interface (BBI), menu driven console interface (MDI), and a command line interface (CLI) with scripting capability are pre-installed in the switch firmware to configure, manage, and monitor the interconnect switch. The interconnect switch also supports Telnet access, simple network management protocol (SNMP), and remote monitoring (RMON). Any combination of the downlink, crosslink, and external ports can be disabled, enabled, configured, and monitored on a per port basis. Out-of-band and in-band access to the switch management interfaces are supported locally and remotely from anywhere on the network. Administration of both switches is possible through any External Ethernet port on either switch and the serial port (Figure 6).

Figure 6. ProLiant BL e-Class C-GbE Interconnect Switch tray external panel



Item	Description
1, 2	Switch B 10/100/1000T Gigabit Ethernet Uplink Ports 25 and 26, RJ-45 Connector
3	Combined interconnect switch and Integrated Administrator Reset Button
4	Switch A 10/100T Fast Ethernet Port 24, RJ-45 Connector
5	Combined interconnect switch and Integrated Administrator Console Port, DB-9 Serial Connector
6, 7	Reserved for future use
8, 9	Switch A 10/100/1000T Gigabit Ethernet Uplink Ports 25 and 26, RJ-45 Connector

Rapid deployment, back-up, and restore

HP Rapid Deployment Pack for Windows version 1.40 or greater (RDP for Windows) introduces a new feature called server-side scripting. With server-side scripting, interconnect switch scripts can be integrated in an RDP for Windows job for deployment of both blade servers and switches. This is ideal for using RDP for Windows to deploy a blade server and then configure associated switch VLANs; however, any scriptable interconnect switch parameter can be integrated.³

HP Rapid Deployment Pack for Windows version 1.40 also includes Altiris Deployment Solution version 5.6 (Altiris v5.6). Altiris v5.6 provides a "Switch Add-on" utility that identifies and manages VLAN settings on the interconnect switches. A utility's Windows 32-bit graphical interface displays a tabular view of the all switches that have been identified, along with their respective switch ports, switch description, and VLAN assignments.

Using either the supported Windows graphical interface or the command line interface, an administrator can:

- View the interconnect switch MIB (management information base) system information via SNMP version 1.
- View the interconnect switch ports and the VLAN setting for each port.
- Add/delete an interconnect switch device to/from the database.
- Modify the VLAN setting of an interconnect switch port via script configuration changes using the CLI or manually using the Windows graphical interface.
- Assign physical connectivity of a discovered device to a switch port (Windows interface only).

³ For more information, see the white paper *Using ProLiant Essentials Rapid Deployment Pack for scripted blade-based switch configuration* at <http://h200006.www2.hp.com/bc/docs/support/SupportManual/c00112018/c00112018.pdf>.

The C-GbE Interconnect Switch supports trivial file transfer protocol (TFTP) allowing a copy of each switch configuration file to be saved and downloaded either to the original switch or to one or more different switches. This provides a method to rapidly deploy multiple systems with similar configurations and to provide backup and restore capabilities. Configuration settings can be modified through the user interfaces or directly within the configuration file. The configuration file has an extensible markup language (XML) format, which allows it to be directly viewed, printed, and edited. The configuration file may even be reset to the factory default settings at any time.

Users can perform firmware operating system upgrades by using TFTP through any external Ethernet port after boot-up, and by using ZModem through the serial interface during boot-up. The interconnect switch simplifies system upgrades by retaining its configuration after a firmware upgrade and by supporting the HP Support Paq automated firmware process for Windows deployment stations.

IP addressing

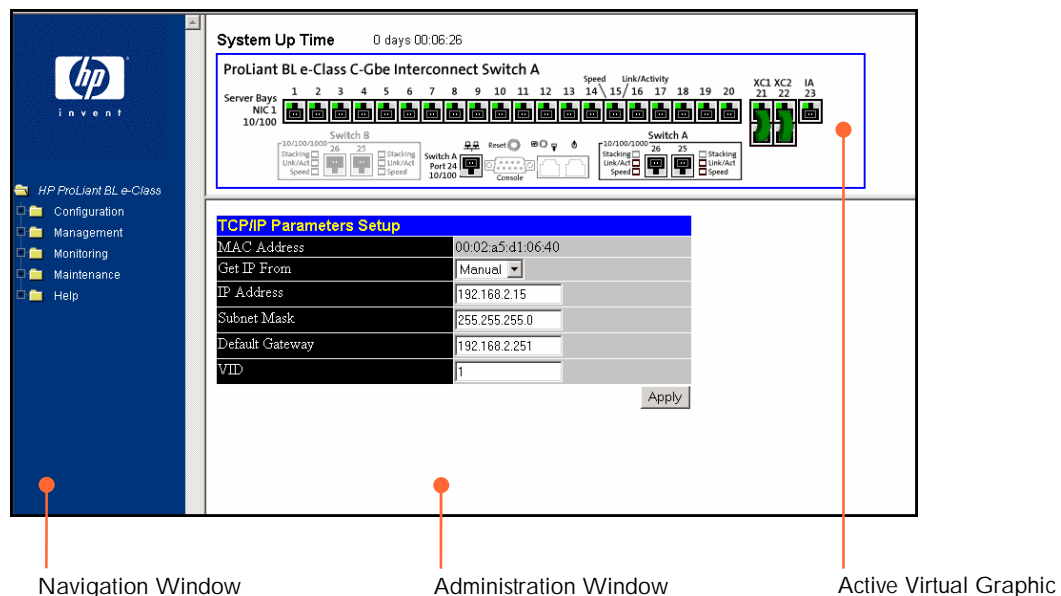
Users can configure each switch to automatically obtain an IP address from a dynamic host configuration protocol (DHCP) or bootstrap protocol (BOOTP) server or they can manually assign an IP address through the command line and menu-driven console interfaces. Users can also assign an IP address from the BBI; however, they would have to reconnect with the newly assigned IP address. For increased security, an administrator can specify the IP-based management stations that are allowed to access each switch.

Web browser-based interface

Users can access the BBI by using Internet Explorer or Netscape Navigator over a TCP/IP network (Figure 7). The BBI interface consists of three main sections:

- The Active Virtual Graphic provides real time status of the switch front panel and provides the means to quickly view statistics of individual ports.
- The Navigation Window contains particular items or features to select.
- The Administration Window contains options for viewing or altering switch information.

Figure 7. Browser-based interface for ProLiant BL e-Class C-GbE Interconnect Switch



Switch security

The interconnect switch uses a layer 2 access control list or filtering database to segment the network, control communications between segments, and provide intrusion control. Each switch allows manual entry of specific media access control (MAC) addresses to be filtered from the network. Filtering of both unicast and multicast traffic is possible. The maximum number of MAC addresses learned on a per port basis may further be restricted.

Several additional features are provided on each switch to allow the network administrator to secure the management interfaces. These features include the ability to:

- Configure multiple password protected accounts with various levels of access.
- Specify the IP-based management stations that are allowed to access each switch.
- Disable web-based and Telnet access and set a user interface idle time-out period.
- Configure port-based IEEE 802.1Q tagged VLANs for server grouping and data isolation.

Diagnostics

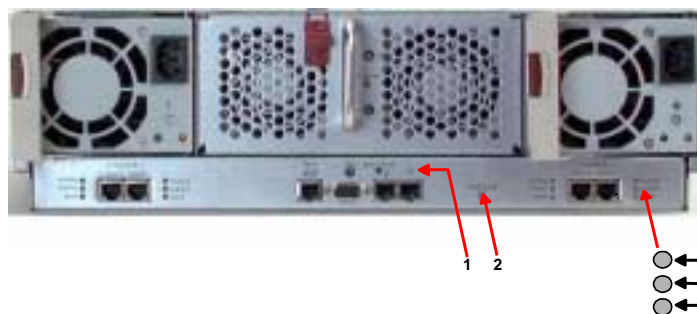
The interconnect switch option includes a removable [Integrated Administrator](#)⁶ module (Figure 9). The ProLiant Integrated Administrator provides a single management console for the efficient management of a server blade enclosure and its accompanying server blades. This includes automatic health monitoring of the switches with SNMP trap generation and system LED status updates.

Figure 9. ProLiant BL e-Class Integrated Administrator



External LEDs are provided for enclosure and switch status and for link and speed on each gigabit RJ-45 connector (Figure 10). An emergency enclosure shut-down feature is included in case of critical system temperature caused by the switch or other enclosure component.

Figure 10. C-GbE Interconnect Switch tray external panel LEDs



Item	Description
1	Integrated Administrator Health
2	Interconnect Switch Health
3	Reserved for future use
4	Link Activity Status
5	Link Speed Status

⁶ Additional information is available at <http://h18000.www1.hp.com/products/servers/proliant-bl/e-class/integrated-admin.html>.

The interconnect switch provides many additional serviceability and diagnostic features including:

- Port mirroring with the ability to mirror desired type of frames (egress, ingress, or both).
- Power on self test (POST) at boot for hardware verification.
- Monitoring screens via the user interfaces for port utilization, data packets received/transmitted, error packets, packet size, trunk utilization, SNMP data, etc.
- Details of system information via the user interfaces such as port parameters and link status, switch asset information, configuration values, log entries, etc.
- The ability to "ping" to test the connectivity on the Ethernet network.
- Local system log (syslog) with ability to view and clear messages that may be saved (uploaded) as text file via TFTP.
- MAC addresses view, clear, and delete from the forwarding database for identifying problems with MAC address learning and packet forwarding.
- The ability to set each switch to a valid firmware image in case of firmware corruption.

For more detailed information on the administration capabilities of the interconnect switch, see the [ProLiant BL e-Class C-GbE Interconnect Switch user guides](#).⁷

Virtual LAN

Each switch supports 256 port-based IEEE 802.1Q virtual LANs (VLANs) with GVRP dynamic VLAN registration⁸. Members of a VLAN may be untagged and tagged ports according to IEEE 802.3ac VLAN Ethernet frame extensions for 802.1Q tagging. Therefore, C-GbE Interconnect Switch VLANs may span other switches that support 802.1Q tagging located within the network infrastructure.

Spanning tree

The interconnect switch meets the IEEE 802.1D spanning tree protocol (STP) to eliminate potential problems caused by redundant networking paths. Users can configure STP switch parameters, including priority and cost, on a per port basis. Each switch can automatically find the STP root bridge on the network. Otherwise, the switch will act as the root bridge for the STP domain.

For networks designed without loops or individual switch ports connected to server blades or other devices where a loop does not exist, the interconnect switch permits STP to be:

- Disabled on a per switch or per port basis.
- Placed in a bypass mode (Cisco PortFast equivalent) on a per port basis allowing a port to skip the standard STP modes and enable itself directly in the forwarding state.

EtherChannel compatible link aggregation

The interconnect switch complies with IEEE 802.3ad static link aggregation (excluding LACP⁹) compatible with Cisco EtherChannel (Fast EtherChannel, Gigabit EtherChannel). Each switch supports six multi-port trunks with up to eight ports per trunk.

Internet group management protocol

The interconnect switch provides internet group management protocol (IGMP) snooping v1 and v2, configurable to a non-querier mode. The IGMP state may be enabled and disabled on a per VLAN basis as well as a configurable response report delay and query interval. Each switch allows a maximum of 191 concurrent multicast groups (127 dynamically learned by IGMP, 64 static multicast).

⁷ Available at <http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/interconnect-switch.html>.

⁸ GVRP stands for GARP VLAN Registration Protocol.

⁹ Link Aggregation Control Protocol.

Data storm prevention

The interconnect switch permits configurable thresholds (in packets per second) to prevent three types of packet storms: broadcast, multicast, and destination address unknown. If the threshold is exceeded, any additional packets received would be dropped.

Quality of service

Support for quality of service (QoS) IEEE 802.1p on the interconnect switch allows switch administrators to set priority levels on each switch for forwarding packets. Each switch supports four classes of traffic (buffers or queues) for implementing priority based on the priority tag of the packet. Administrators can map up to eight priority levels to four classes. Traffic from a specific server port can be given priority over packets from other devices according to this range of priority levels. For example, with multiple packets in a buffer, the packet with the highest priority would be forwarded first, regardless of when it was received.

Enterprise-class performance

The C-GbE Interconnect Switch tray includes the following performance features:

- Non-blocking, full wire speed on all ports.
- 8.2 Gb/s external port bandwidth per server blade enclosure (full duplex).
- 6.1 million packets per second maximum external port frame forwarding throughput per server blade enclosure (64-byte packets).
- 8,191 MAC addresses per switch with automatic MAC address learning.
- 32-MB Main, 6-MB flash, and 16-MB packet buffer memory per switch (packet buffer memory shared between ports).

ProLiant Network Adapter Teaming

ProLiant Network Adapter Teaming is typically used to provide fault resiliency for the NICs within the team. If one NIC should fail, the surviving NICs maintain network connectivity. However, network adapter teaming may also be used to maintain network services if an Ethernet switch fails. The architecture of the ProLiant BL system allows for both network adapter and interconnect switch fault tolerance when using ProLiant Network Adapter Teaming.

The ProLiant servers include standard HP NC series network adapters that support all three types of ProLiant Network Adapter Teaming:

- Network Fault Tolerance (NFT)
- Transmit Load Balancing (TLB)
- Switch-assisted Load Balancing (SLB)

When teaming HP NC series network adapters with the interconnect switch, NFT and TLB teaming are the same as with any ProLiant system. However, for SLB teaming, the pre-defined switch-to-server architecture across the server blade enclosure's backplane must be considered. SLB requires that all NICs in the team must be connected to the same switch.

The C-GbE Interconnect Switch redundant crosslinks add significant advantages when configuring teaming for switch fault tolerance. For details, see the [HP ProLiant network adapter teaming](#) white paper¹⁰ located on the ProLiant teaming home page.

¹⁰ Available at <http://ftp.compaq.com/pub/products/servers/networking/TeamingWVP.pdf>.

Conclusion

The ProLiant e-Class C-GbE Interconnect Switch is available as one of three interconnect tray options for the ProLiant BL e-Class system. The C-GbE Interconnect Switch tray option includes a pair of fully redundant, managed layer 2 Ethernet switches that consolidate up to forty 10/100 Mbps network adapters to one to four 10/100/100T Gigabit Ethernet uplinks. The switch is ideal for users who desire greatly decreased network cabling for a significant reduction in the time required to deploy, manage, and service ProLiant BL e-Class systems.

Appendix: Summary of features of the ProLiant BL e-Class C-GbE Interconnect Switch

Switch performance

- Non-blocking full wire speed architecture
- Store and forward mode layer 2 switching standard
- Support for 3rd party external layer 7 content delivery switch / appliance
- Support for F5 BIG-IP Blade Controller load balancer and traffic management
- Frame forwarding throughput of 1.488 million packets per second (per Gigabit port)
- Frame forwarding throughput of 0.1488 million packets per second (per Fast Ethernet port)
- 6.1 million packets per second maximum external port (uplink) frame forwarding throughput per server blade enclosure (64-byte packets)
- 8.2 Gb/s External port (uplink) bandwidth per server blade enclosure (full duplex)
- 32 MB Main, 6 MB flash, and 16 MB packet buffer memory per switch (packet buffer memory shared between ports)
- Auto-negotiation and auto-sensing with full-duplex support and ability to manually force port speed and duplex mode
- Auto-MDI/MDIX on all ports enabled with auto-negotiation
- 8,191 MAC addresses per switch with automatic MAC address learning
- ARP for IP to MAC address resolution

Switch network features

- IEEE 802.3 10Base-T Ethernet, IEEE 802.3u 100Base-TX Ethernet, and IEEE 802.3ab 1000Base-T Ethernet
- IEEE 802.1D spanning tree protocol (mono-spanning tree)
- Spanning tree bypass fast forwarding mode on a per port basis (Cisco PortFast equivalent)
- Enable/disable and configure spanning tree port cost and priority on a per port basis
- IEEE 802.3ad link aggregation (excluding LACP) supporting up to 6 multilink trunk groups with 8 ports per group; compatible with Cisco EtherChannel trunking (Fast EtherChannel, Gigabit EtherChannel)
- 256 IEEE 802.1Q port based VLANs per switch
- IEEE 802.3ac VLAN Ethernet frame extensions for 802.1Q tagging on a per port basis
- Ports may be tagged or untagged members of a VLAN
- GARP VLAN registration protocol (GVRP) providing 802.1Q compliant VLAN pruning and dynamic VLAN creation
- IEEE 802.1p QoS with 4 classes of service mapped to 8 priority levels
- IGMP snooping v1 and v2, configurable to a non-querier mode
- IGMP state enabling and disabling on a per VLAN basis
- IGMP response report delay and query interval configuring
- 191 Maximum concurrent multicast groups (127 dynamically learned by IGMP, 64 static multicast)
- Broadcast, multicast, and unknown packet storm control with a configurable threshold value
- IEEE 802.3x flow control with manual configuration capability
- Primary and secondary SNTP (simple network time protocol) server with time zone support and automatic daylight savings adjustment

Switch deployment and configuration

- Supports any combination of ProLiant BL e-Class server blades
- Default pre-configuration for immediate plug-in operation in the server blade enclosure
- Communicate to any and all server blade network adapters from any Ethernet external port
- Manage both switches, access all iLO ports, and execute PXE from any external Ethernet port
- Web-based interface accessible from any switch Ethernet port
- Menu driven console interface accessible from any switch port
- Command line interface (CLI) with scripting capability accessible from any switch port
- Telnet access to the CLI and menu-driven console interfaces accessible from any switch Ethernet port
- SNMP-based scripting with best-case HP recommended example scripts
- Integrated switch scripting within Rapid Deployment Pack for Windows v1.40 or greater
- Altiris Switch Add-on utility in Rapid Deployment Pack for Windows v1.40 or greater
- Serial line IP (SLIP) access to command line and menu-driven console interfaces
- Configurable forwarding MAC address aging time settable to any value from 1 to 1 million seconds (default is 300 seconds)
- MAC address user management sorting on a per port and per VLAN basis
- Manual (static) entries in MAC address table
- Manual, or automatic IP settings via a DHCP or BOOTP server
- Ability to restore switch to factory default settings
- TFTP to upload and download (save, restore, and update) the switch configuration file and operating system
- ZModem to download the switch firmware (restore and update) via the serial interface
- Switch configuration retention after firmware upgrade
- HP Support Paq automated firmware upgrade process for Windows deployment stations
- Human read/write configuration file for viewing, printing, and editing
- Pre-configured customized port naming with respect to server blade NIC connectivity
- Per port bandwidth control of ingress and egress traffic
- Ability to name ports on a per port basis
- Full ability to enable and disable any port (both internal and external ports) on both switches

Switch diagnostics and monitoring

- System and management status LEDs
- Per port speed and link activity LEDs adjacent to all external Ethernet ports
- Active virtual graphic in the web-based switch interface
- Port mirroring with ability to mirror desired type of frames (egress, ingress, or both)
- Switch statistic monitoring including port utilization, data packets received/transmitted, port error packets, packet size, trunk utilization, SNMP data, etc
- System reporting such as port parameters and link status, switch asset information, configuration values, log entries, etc.
- Ping capability to test the connectivity on the Ethernet network
- SNMP v1 with four configurable community strings and SNMP trap manager hosts
- MIB-II, Bridge MIB, Interface MIB, Extended Bridge MIB, Ethernet-like MIB, Entity MIB, and HP enterprise switch MIBs
- Bridge, remote monitoring, and switch environmental traps
- Pre-registered (compiled) switch MIBs with Insight Manager 7
- Insight Manager 7 automatic discovery, identification, and receiving of traps and events
- Insight Manager 7 standard database activities (queries, tasks, reporting, etc)
- Power on self test (POST) at boot for hardware verification
- Ability to return switch to a valid firmware image in case of firmware corruption
- Local system log (syslog) with ability to view and clear messages, and save (upload) as text file via TFTP

Switch security

- Password protected multi-level user accounts supported on all management interfaces
- Configurable user interface idle time-out period
- Ability to disable web-based and Telnet access to the switch user interfaces
- 256 Port-based IEEE 802.1Q tagged VLANs per switch (512 per server blade enclosure)
- Ability to specify the IP-based management stations that is allowed to access the switch
- Unicast and multicast static MAC address packet filtering table (layer 2 access control list)
- Restriction on the maximum number of MAC addresses learned on a per port basis

Switch availability

- Redundant switches per server blade enclosure
- Redundant uplink ports per switch
- Redundant crosslink ports for switch to switch communication and failover scenarios within the server blade enclosure
- Redundant N+1 hot-plug redundant power and fans
- IEEE 802.3ad automatic multi-link load balancing and link failover (excluding LACP)
- Load balancing of unicast traffic
- ProLiant network adapter teaming
- Redundant configurable community strings and SNMP trap manager hosts
- Redundant configurable SNMP servers

Switch ports per server blade enclosure

- Four external 10/100/1000T Gigabit Ethernet ports (two per switch)
- One additional external 10/100T Fast Ethernet port from switch A
- One external DB-9 serial port providing access to the Integrated Administrator and the two switches
- 40 internal 10/100 Fast Ethernet ports to server blade network adapters (two per server bay)
- Two internal 10/100 Fast Ethernet inter-switch crosslink ports per switch for switch-to-switch communication and failover scenarios
- I²C Switch to management module communications
- All external Ethernet ports may be used for data, switch and Integrated Administrator management, and/or PXE remote configuration.
- All internal Ethernet signals routed as Ethernet across individual CAT5e signal traces
- Five RJ-45 external Ethernet port connectors

Switch physical and environmental

- AC power input (at server blade system level)
- 80 Typical and 100 maximum watts power consumption per interconnect switch tray
- Local power reset/power cycle button per interconnect switch tray
- Remote reset/power cycle via user interface
- 0 to 50 operating and -30 to 70 storage temperature (Celsius)
- 5% to 95% operating and 0% to 95% storage relative humidity
- FCC Class A, CE Class A, and VCCI Class A electromagnetic interference (EMI) certifications
- UL/CUL and TUV/GS safety certifications
- 1.4 pounds per interconnect switch tray

For more information

For additional information, refer to the resources detailed below.

Resource description	Web address
ProLiant BL e-Class C-GbE Interconnect switch home page	http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/interconnect-switch.html
<i>ProLiant BL e-Class System Overview and Planning</i> white paper	http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/documentation-q2.html
<i>Using ProLiant Essentials Rapid Deployment Pack for scripted blade-based switch configuration</i> white paper	http://h200006.www2.hp.com/bc/docs/support/SupportManual/c00112018/c00112018.pdf
ProLiant BL e-Class C-GbE Interconnect Switch user guides	http://h18004.www1.hp.com/products/servers/proliant-bl/e-class/interconnect-switch.html
ProLiant network adapter teaming	http://www.compaq.com/products/servers/networking/teaming.html
F5 BIG-IP Blade Controller for ProLiant BL systems	http://h71028.www7.hp.com/enterprise/html/4557-0-0-0-121.html

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